Description and Installation of ALL/TROL Control System Allison Model PD-48-A2

Contract NAS 8-5045

Engineering Department Report No. 3224

Allison Division
General Motors Corporation
Indianapolis, Indiana

t: Description and Installation of ALL/TROL Control System, Allison Model PD-48-A2

(NASA Contract NAS 8-5045)

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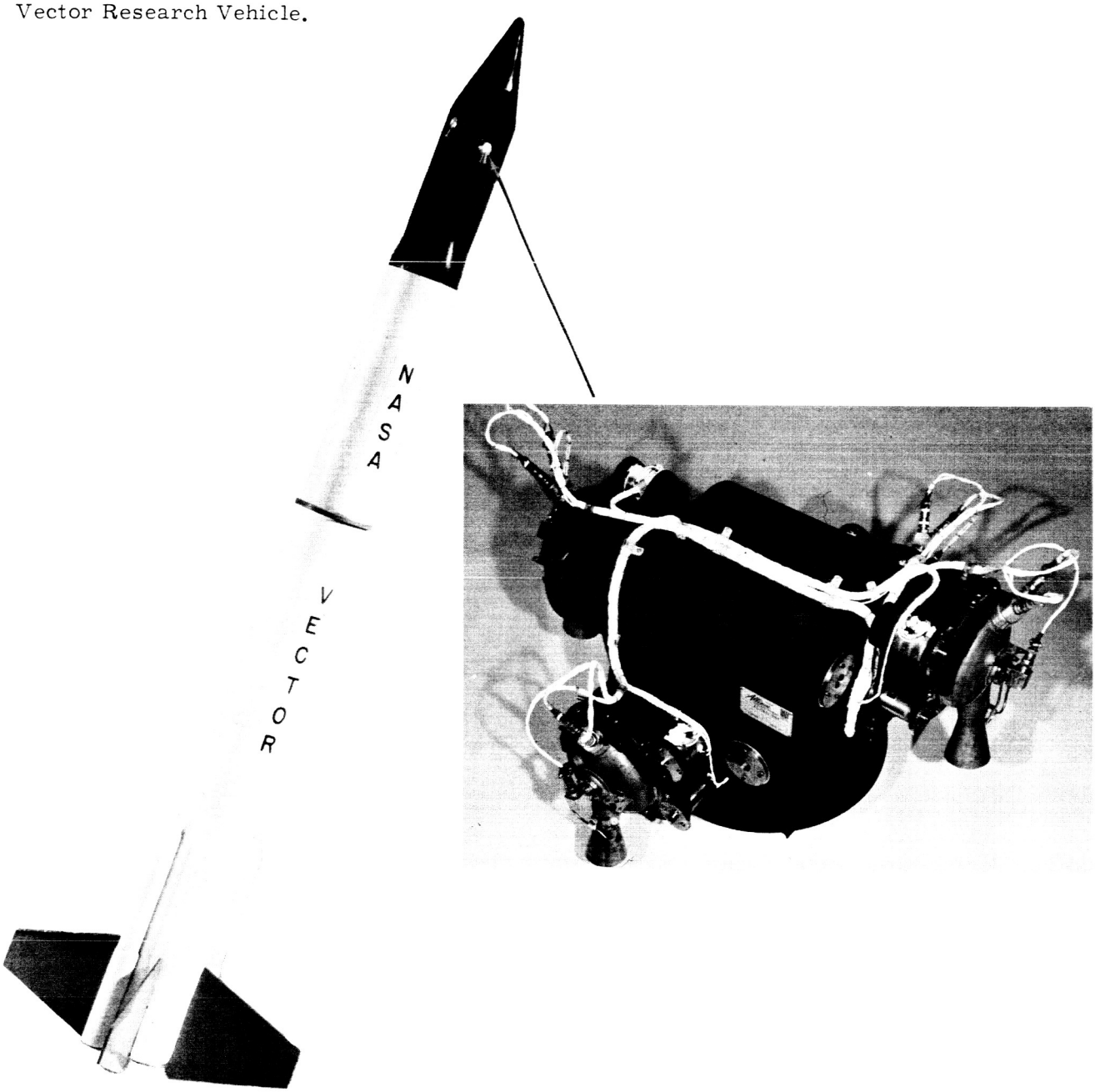
INTRODUCTION

This document describes the PD-48-A2 attitude and velocity control system (designated ALL/TROL) and the procedures to be followed for assembly and installation of the control rocket. The control system is manufactured by the Allison Division of General Motors Corporation, under NASA Contract NAS 8-5045, for use on the second stage of the NASA Vector Research Vehicle.



SECTION I

DESCRIPTION

1-1. GENERAL DESCRIPTION

1-2. The control system contains all the components and wiring necessary to receive guidance signals from an external source and convert these electrical signals into a corrective force by rotation of the control rockets.

1-3. CONTROL SYSTEM

1-4. The PD-48-A2 attitude and velocity control system consists of four solid propellant rocket motors, an actuation motor and position feedback potentiometer for each control rocket, support structure, electrical harness, and a mounting flange for installation on the Vector Research Vehicle. Photographs of the complete control system are shown in Figures 1-1 and 1-2. The control rockets are located so that one pair of parallel rockets rotated in the same direction will provide control in the yaw plane and the other pair of rockets provide control in the pitch plane. Differential rotation of the rockets for either one pair or both pairs will provide roll control.

1-5. The control system final assembly and installation drawing is shown in Figure 1-3. The envelope and mounting attachment location are shown in this layout.

1-6. CONTROL ROCKET MOTOR

1-7. The control rocket is a solid propellant end-burning motor with the nozzle located at 80 degrees to the propellant grain center line.

1-8. The rocket motor assembly with a nozzle for optimum expansion at sea level conditions is shown in Figure 1-4, and with the flight nozzle in Figure 1-5. The nozzle closure assembly is attached to the case assembly with a threaded joint. The aft bearing is mounted on the nozzle closure. A stub shaft on the forward dome provides a mounting for the forward ball bearing. A gear is also mounted to the aft nozzle closure to drive the rocket motor. The main igniter is located on the center of the nozzle closure as shown in Figure 1-1.

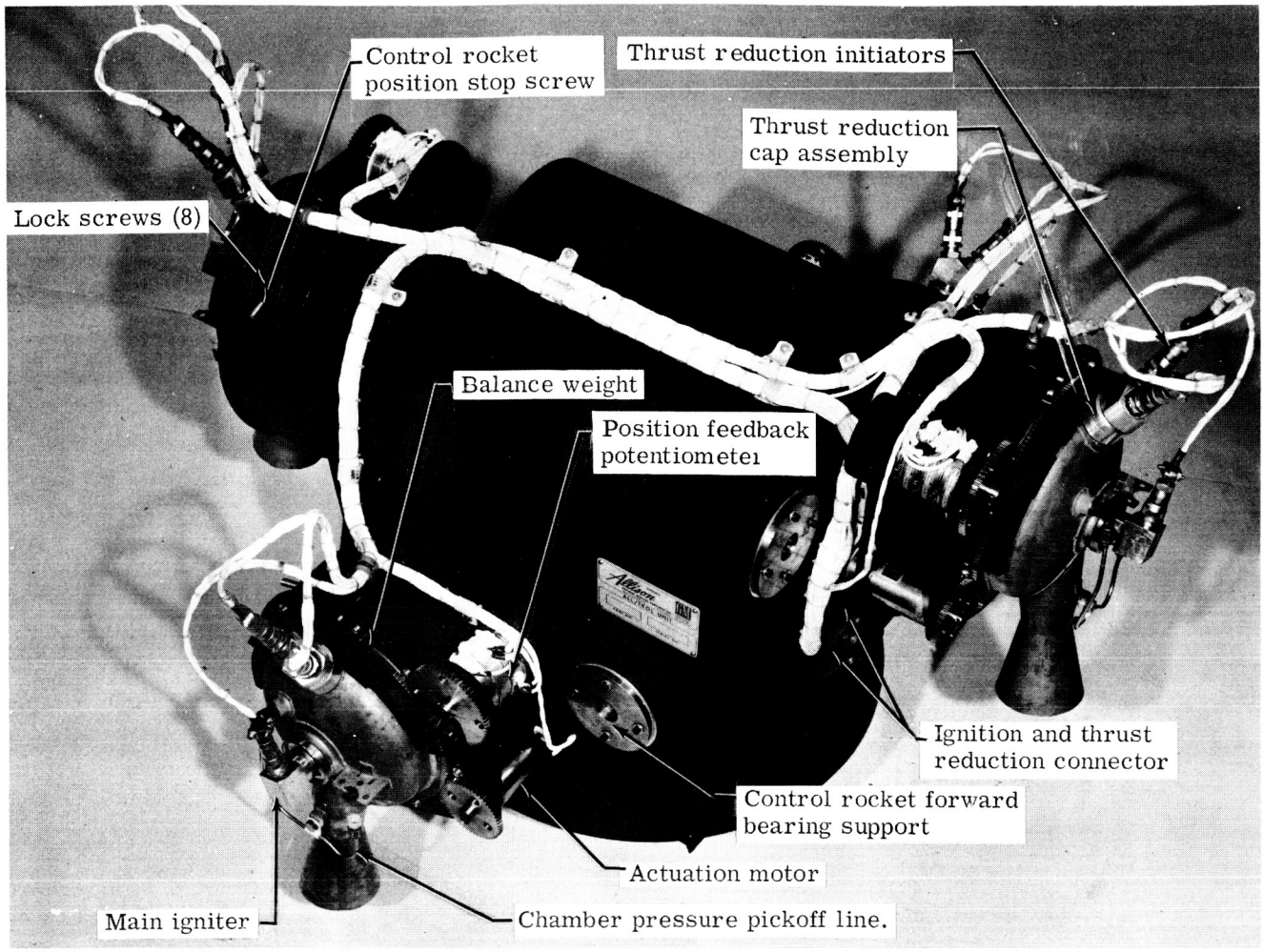


Figure 1-1. Three-quarter side view of PD-48-A2 ALL/TROL system.

1-9. A port is provided on the nozzle closure with a blow-off cap for thrust magnitude control. An electrical signal from the guidance unit or some other source will actuate pyrotechnic pressure cartridges in the thrust reduction cap, causing the cap to separate from the rocket motor and thus provide a secondary nozzle. The secondary nozzle provides a thrust component in the direction opposite to the main nozzle.

1-10. Vehicle velocity control is provided by blowing off the thrust reduction cap at the desired vehicle velocity, thereby providing either a net negative, zero, or positive thrust as determined by the design port size. The motors for the PD-48-A2 have been designed with a small net positive thrust.

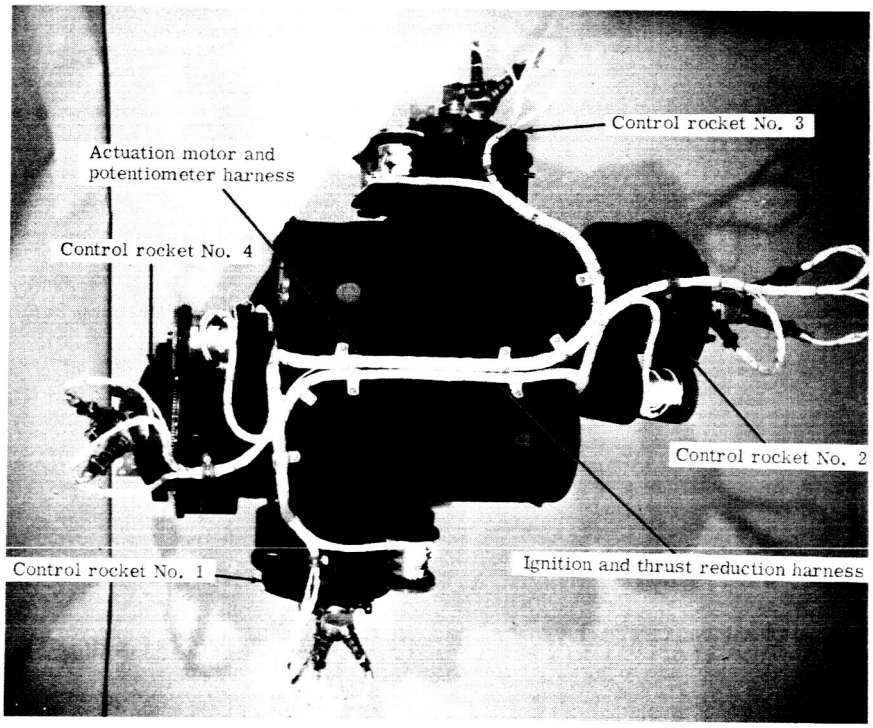


Figure 1-2. Top view of PD-48-A2 ALL/TROL system.

1-11. MAIN IGNITER ASSEMBLY

1-12. The main igniter assembly is shown in Figure 1-6. The assembly consists of the igniter, initiator, O-ring for pressure seal, and a snapring for securing to the rocket motor.

1-13. The igniter incorporates dual electrical circuits with dual bridgewires in each circuit.

1-14. The igniter has a no-fire characteristic of 0.5 ampere and a sure-fire characteristic of 3.0 amperes.

1-15. THRUST REDUCTION ASSEMBLY

1-16. The thrust reduction assembly is shown in Figure 1-7. The assembly consists of an insulation plug for the port in the nozzle closure, a ring which prevents the cap from putting stress on the insulation plug, the main cap assembly, and two electrically actuated pyrotechnic

pressure initiators. Each pressure initiator has two electrical circuits with a single bridgewire in each circuit. Actuation of either initiator will blow off the thrust reduction cap.

1-17. The pressure initiators have a no-fire characteristic of 0.5 ampere and a sure-fire characteristic of 1.0 ampere.

1-18. CONTROL SYSTEM WIRING

1-19. The control system has four bulkhead connectors located on the sides of the support frame. These connectors are shown in Figures 1-8 and 1-9. Figure 1-8 shows the two connectors provided for the main ignition and thrust reduction. Figure 1-9 shows the connector provided for the actuation motors and the connector for the position feedback potentiometers.

1-20. The master wiring diagram, shown in Figure 1-10, illustrates the redundant circuits for ignition and thrust reduction. The main igniters and thrust reduction initiators are wired so that one set of bridgewires (in parallel) is connected to one bulkhead connector, shown on Figure 1-8, and the other set of bridgewires (in parallel) is connected to the other bulkhead connector. Thus, by providing electrical power to either bulkhead connector, all four rockets can be fired and/or thrust reduction can be actuated on all rockets. Phasing of the position feedback potentiometers is shown in Figure 1-10.

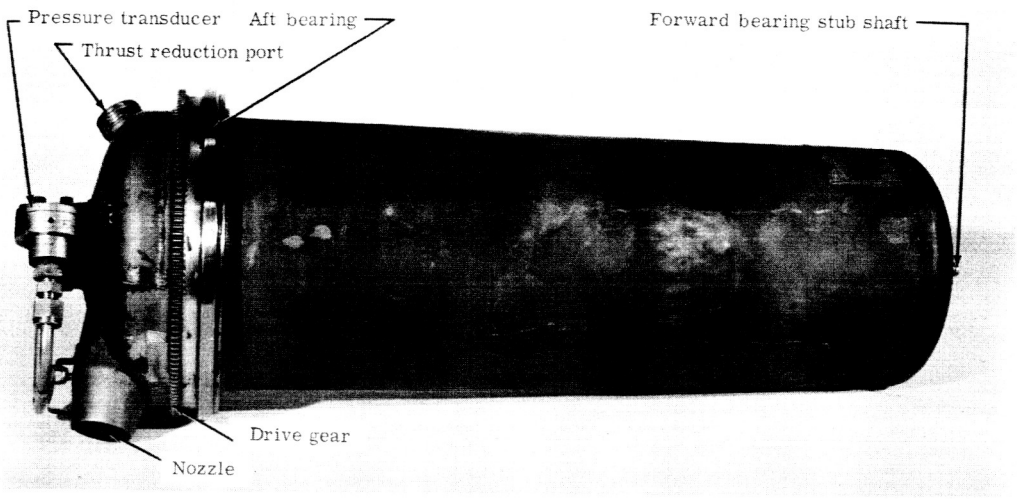


Figure 1-4. Control rocket motor (See level nozzle).

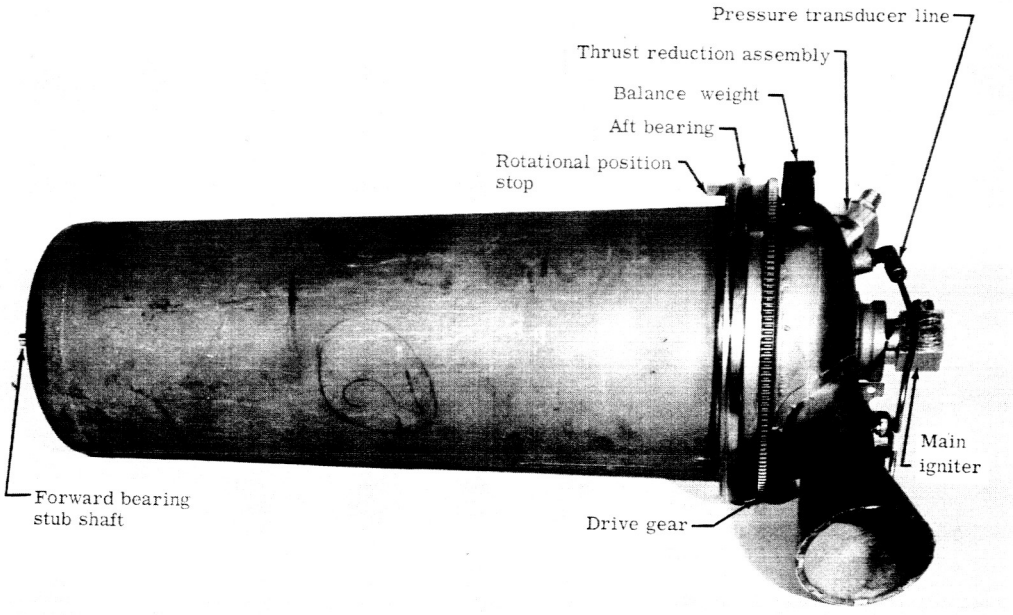


Figure 1-5. Control rocket motor (Altitude nozzle).

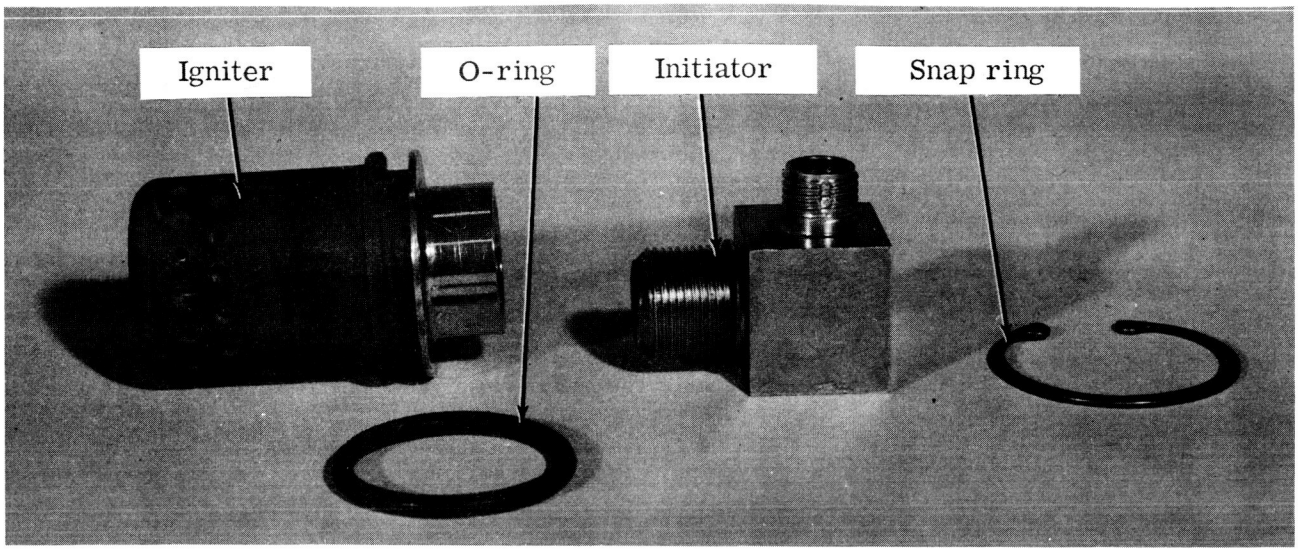


Figure 1-6. Main igniter assembly.

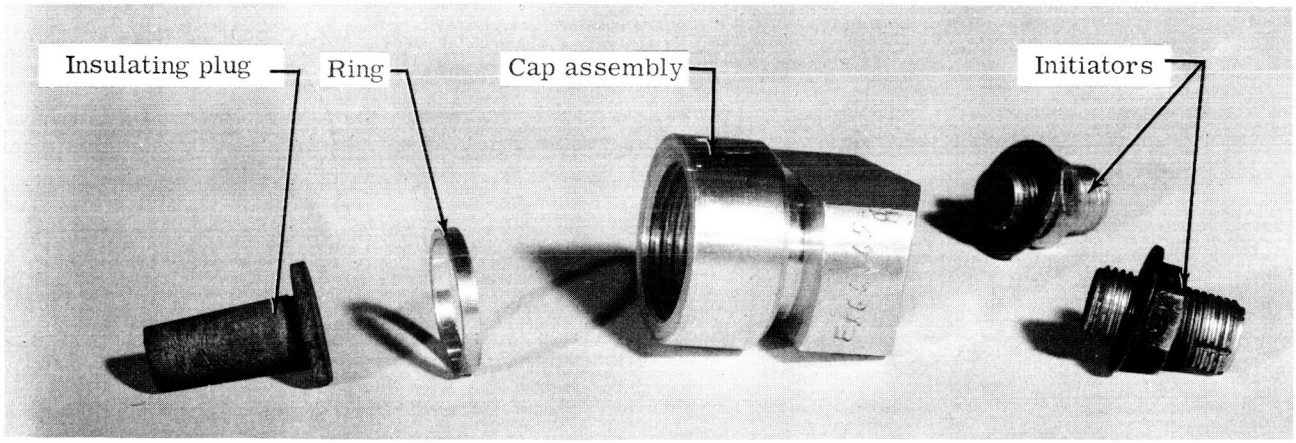


Figure 1-7. Thrust reduction assembly.

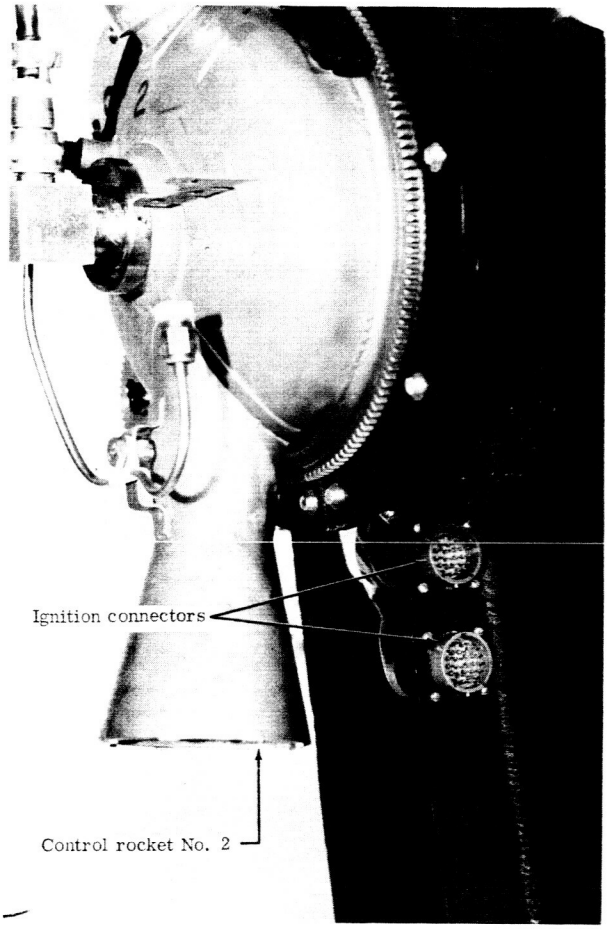


Figure 1-8. Location of main igniter interface electrical connectors.

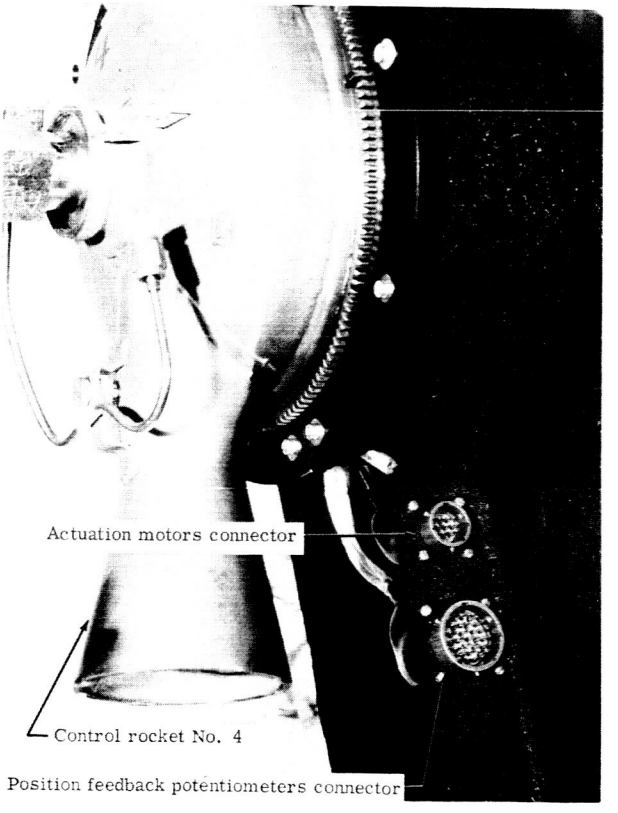
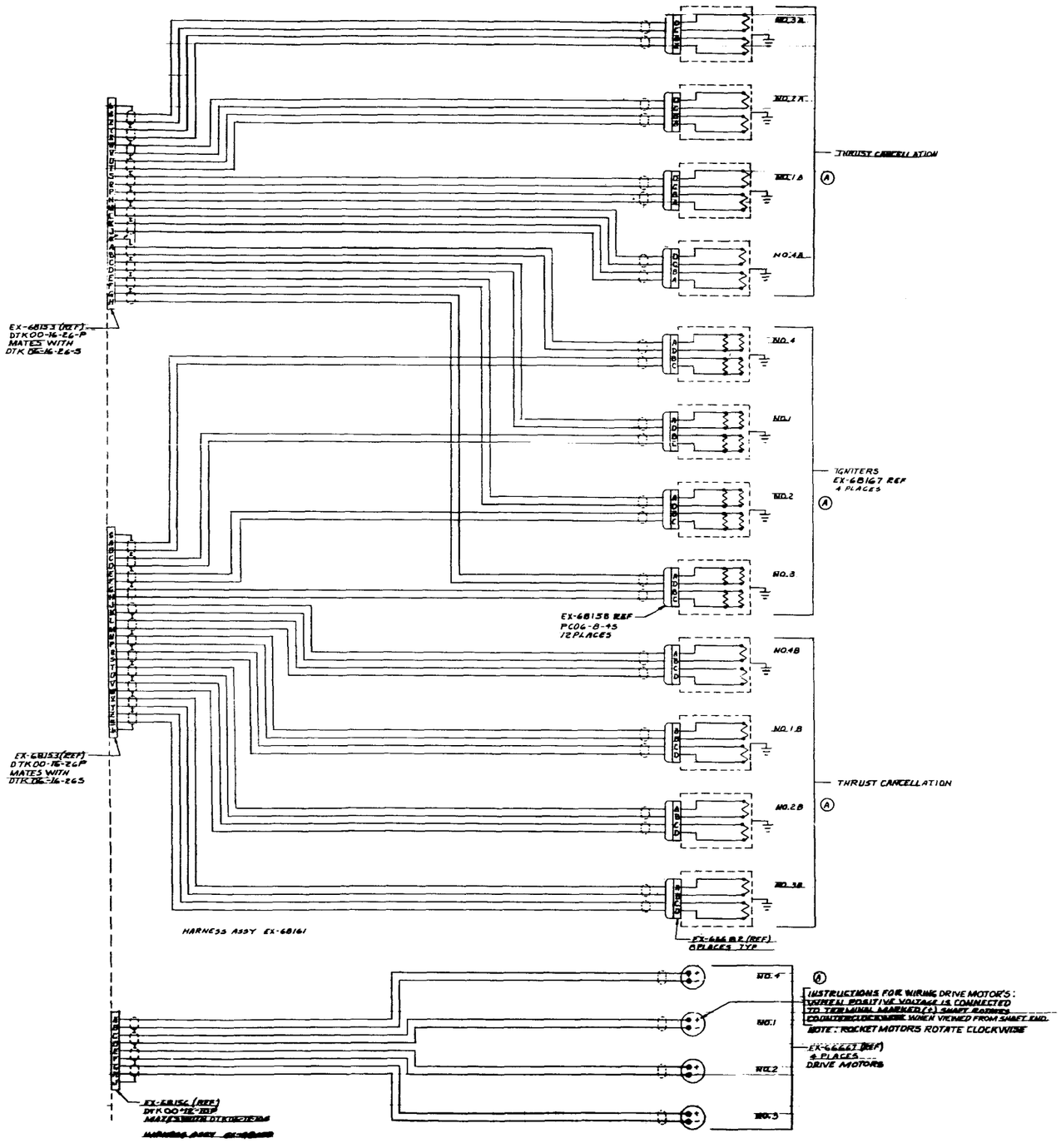
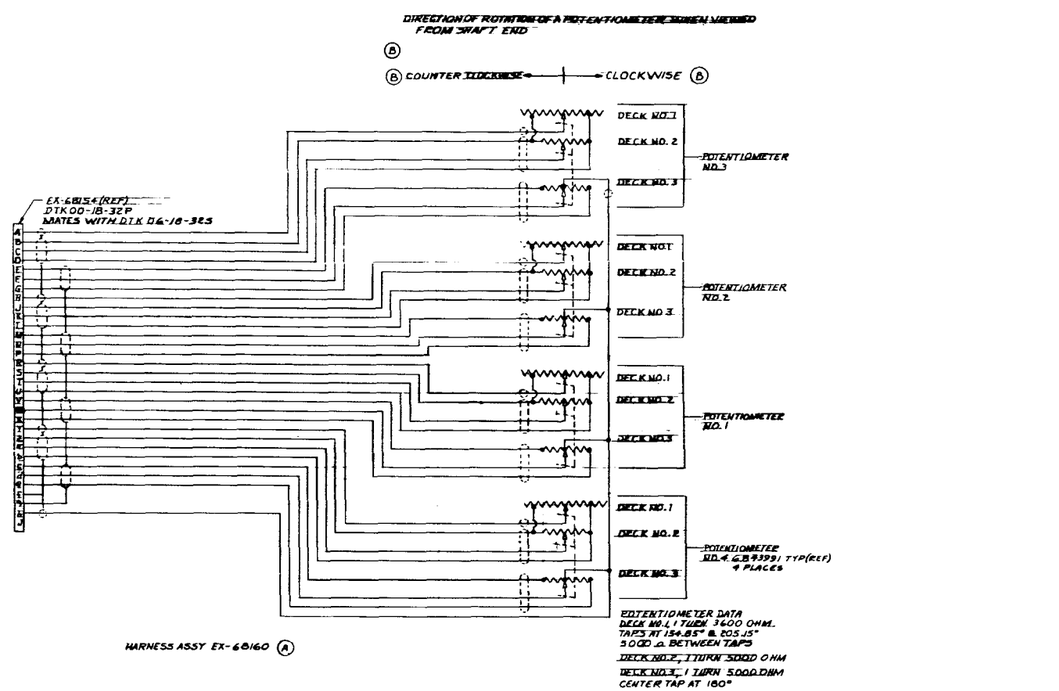


Figure 1-9. Location of interface electrical connectors for actuation motors and feedback potentiometers.





UNLESS OTHERWISE SPECIFIED ALL WIRES TO BE
NO.22 AWG SHIELDED

ALL SHIELDING SHOWN ON DIAGRAM TO BE
INSULATED & CONTINUOUS THROUGHOUT
ENTIRE LENGTH & GROUNDED ONLY AS SHOWN

Figure 1-10. Master wiring diagram.

SECTION II

INSTALLATION AND ASSEMBLY

2-1. INSTALLATION IN VEHICLE

2-2. The control system is attached to the vehicle structure with a mounting plate located on the base of the control system as shown in Figure 2-1. The mounting plate is counterbored for precision alignment with the vehicle. The mounting plate is secured to the vehicle with eight 1/4-inch machine bolts. The bolt locations are shown in Figure 1-3.

2-3. CONTROL ROCKET ASSEMBLY AND INSTALLATION

2-4. The control rockets may be installed in the support frame prior to installation in the vehicle. However, it may be more convenient to install the frame on the vehicle and then install the control rockets. Final control rocket alignment may then be accomplished. The installation procedure for control rockets may be applied to either mode of installation.

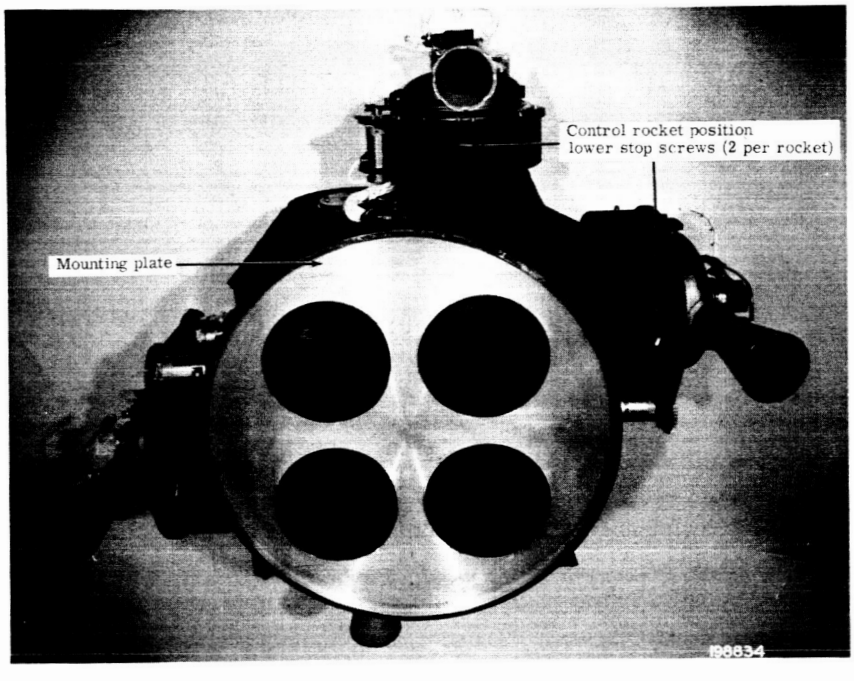


Figure 2-1. Bottom view of PD-48-A2 ALL/TROL system.

2-5. Due to the nonsymmetry of the support frame, the control rocket position stops on the upper and lower closures are reversed. Consequently, the upper and lower rockets are not interchangeable.

2-6. ROCKET MOTOR ASSEMBLY

2-7. The control rocket components are shown in Figure 2-2.

a. Install the O-ring (6735231-195) on the motor case (EX-61093), as shown in Figure 2-3.

b. Lubricate O-ring with silicone grease.

c. Clean all the closure and case threads and apply a suitable lubricant, such as Silver Goop, manufactured by Crawford Fitting Co., Cleveland, Ohio.

d. Strap the motor case in a strap clamp or suitable holding fixture as shown in Figure 2-4.

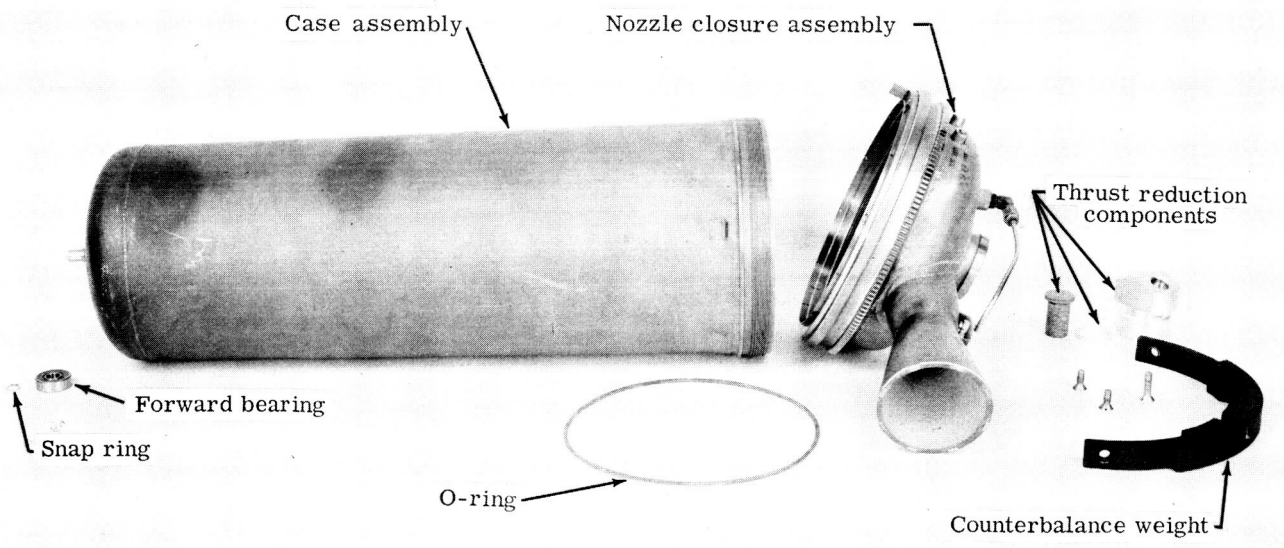
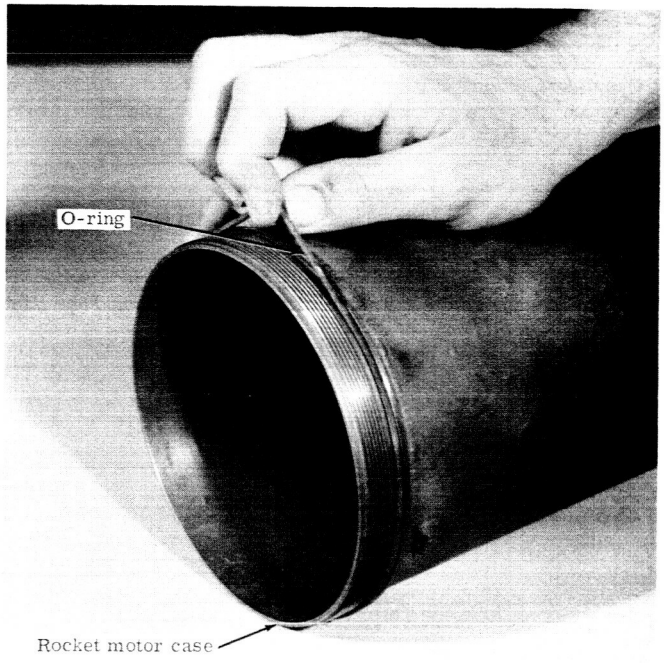


Figure 2-2. Major components of PD-48-A2 control rocket.

Figure 2-3. Installation of O-ring on rocket motor case.



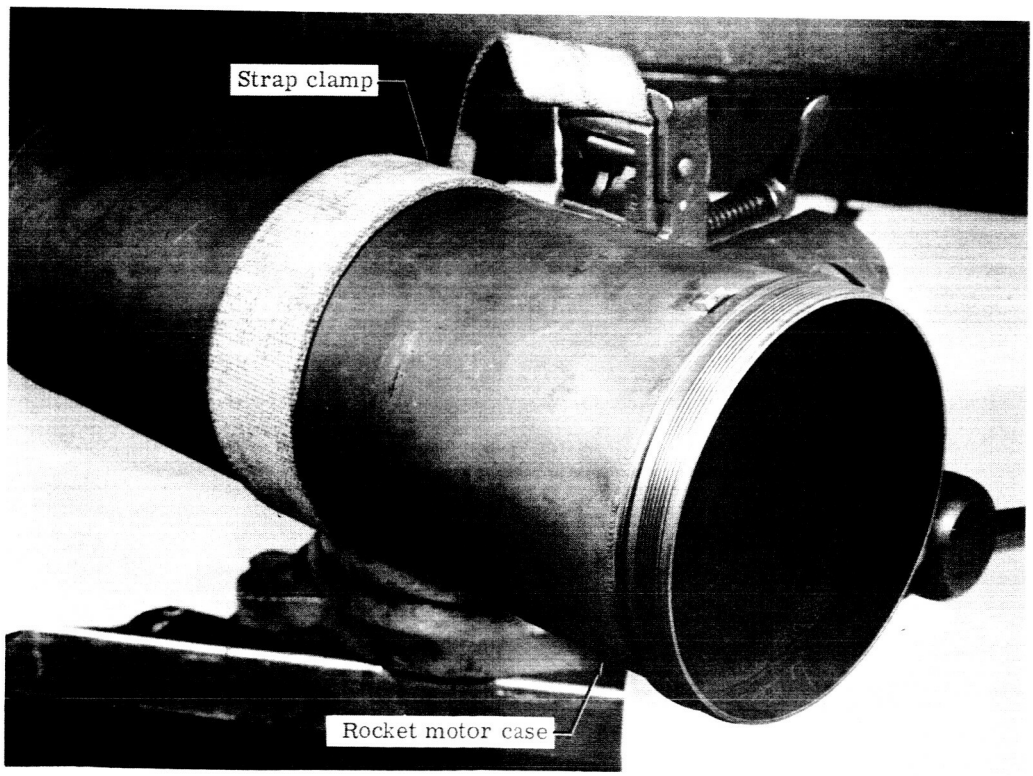


Figure 2-4. Rocket motor case mounted in strap clamp.

e. Screw the nozzle closure (EX-68961) onto the case and tighten with a strap wrench. See Figure 2-5.

CAUTION

Do not allow wrench to bear on the aft bearing.

f. Install safety wire as shown in Figure 2-6.

g. Apply Teflon thread sealant to the thrust reduction port threads on the nozzle closure.

h. Install the insulating plug (EX-66666) in the thrust reduction port.

i. Install the aluminum ring on top of the port.

j. Screw the thrust reduction cap (EX-66665) onto the port. Tighten the cap assembly with a spanner wrench. See Figure 2-7.

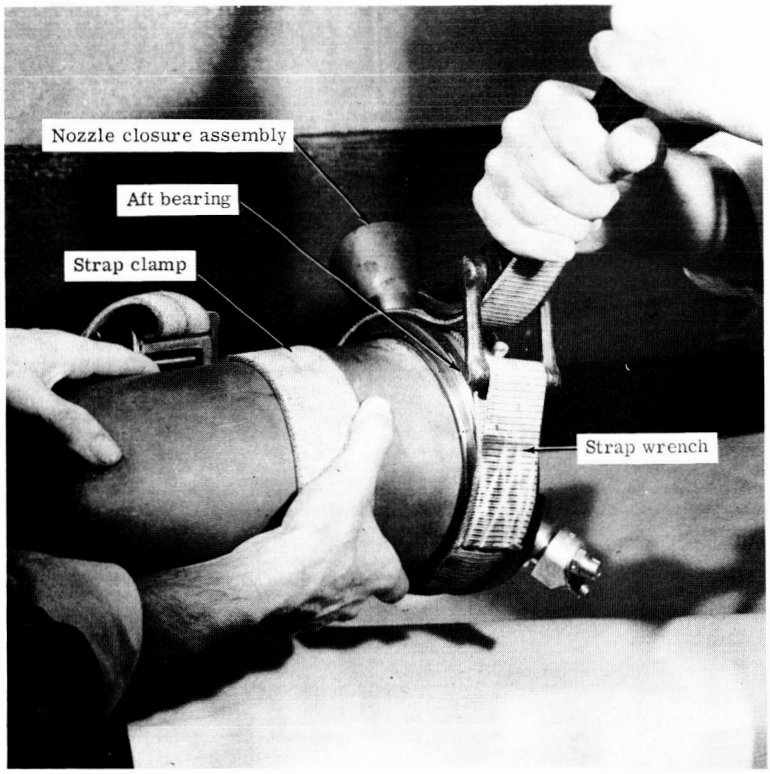


Figure 2-5. Tightening nozzle closure on case.

CAUTION

Do not use a wrench on the upper section of the cap assembly. Torsional strain damage could occur to the shear section if this were done.

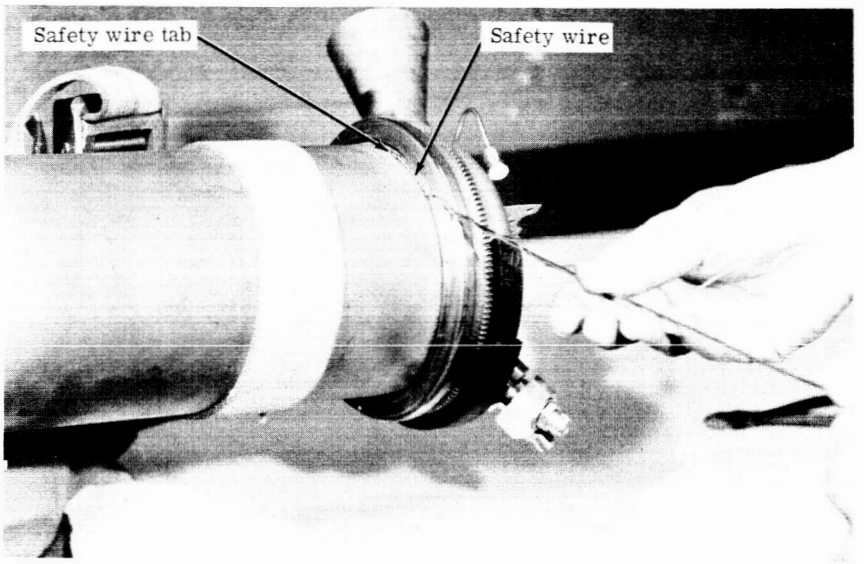


Figure 2-6. Safety wiring nozzle closure to case.

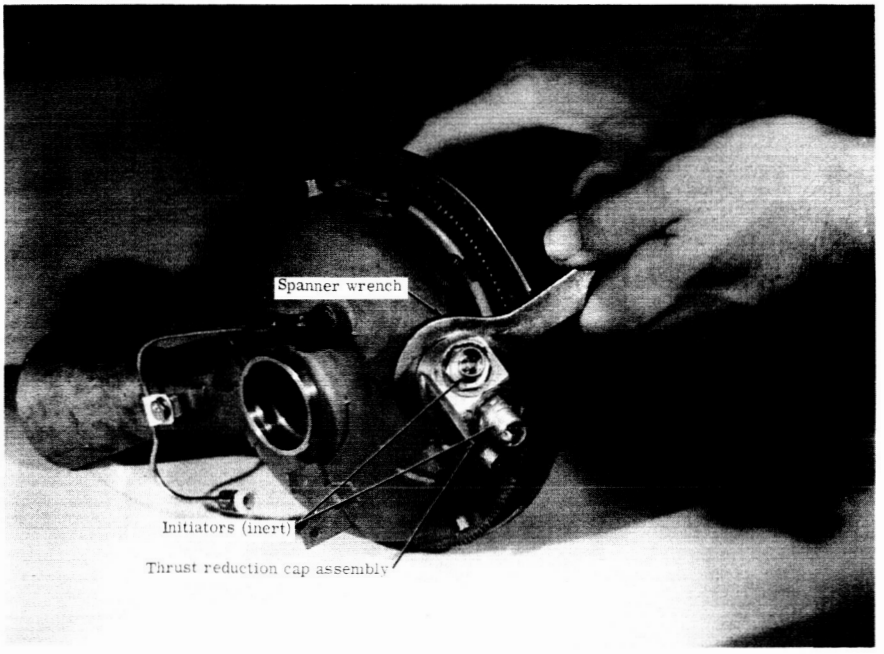


Figure 2-7. Tightening thrust reduction cap on nozzle closure.

2-8. ROCKET MOTOR INSTALLATION

2-9. The control rocket motors will be matched and marked for a particular location in the frame.

a. Install the forward bearing on stub shaft (EX-66681) and secure with snapring (6823303-31).

b. Clean all dirt from the aft bearing housing and the outer race of the aft bearing on the nozzle closure.

c. Check wiring harness and ignition connectors to ensure they are not blocked inside the frame when the control rocket is installed.

d. Insert the rocket motor (EX-68967—upper and EX-68968—lower) through the frame, then guide the forward bearing into the forward bearing housing.

e. Press the motor into place by hand and, at the same time, start the retainer plate (containing the actuation motor and feedback potentiometer) over the locating dowel pins on the frame as shown in Figure 2-8.

f. Install the retaining ring. Install rubber grommets and screws (apply Loctite to all screws) with flat washers. (Screw P/N—AN116916, Washer P/N—AN122577). See Figure 2-9.

g. Safety wire all screws in pairs.

NOTE

Do not safety wire any pair in the areas adjacent to the feedback potentiometer or drive motor. These areas must remain open for the gears.

2-10. POSITION FEEDBACK GEARS

2-11. The position feedback gears are stamped with the position number and scribed for location on the potentiometer shaft.

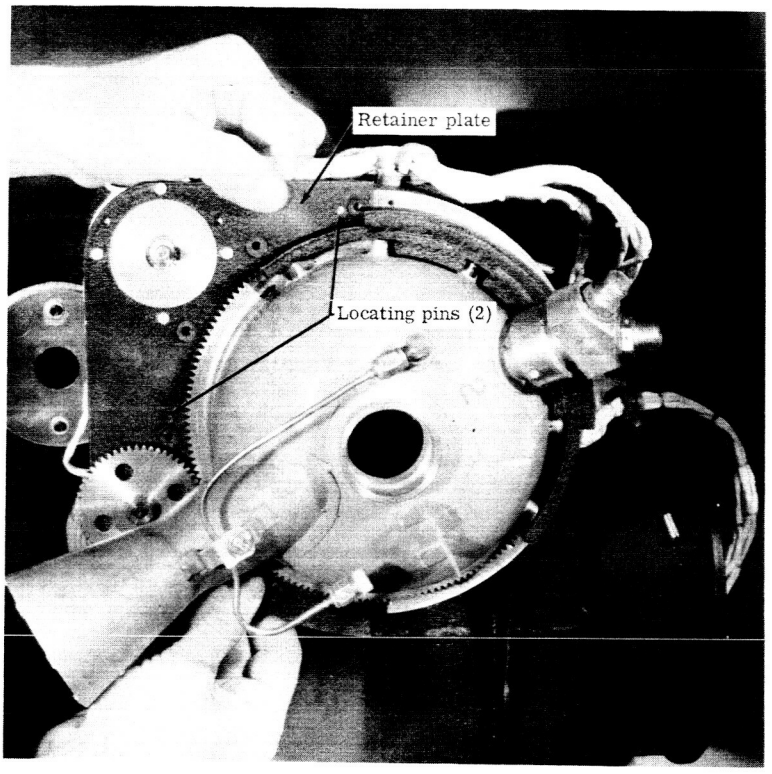


Figure 2-8. Installation of control rocket.

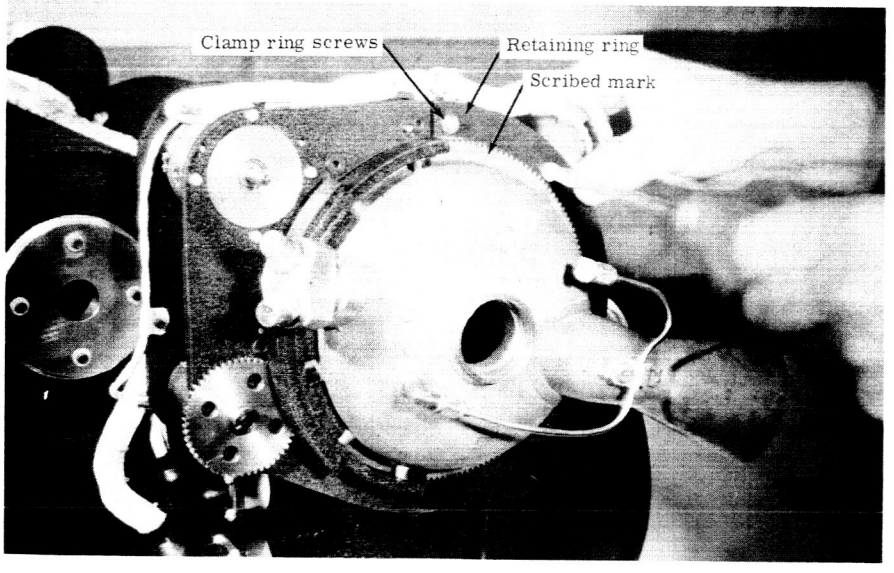


Figure 2-9. Installation of retaining ring.

a. Connect an ohmmeter across the No. 3 deck of the potentiometer wiper and center tap of the rocket motor being aligned. For example, on rocket motor No. 1, connect across pin W and pin h.

b. Rotate the potentiometer until the ohmmeter indicates a minimum resistance of 0-7 ohms.

c. With the special alignment protractor, align the rocket to null position as shown in Figure 2-10. The nozzle closures have been scribed at 90° from nozzle center line. See Figure 2-9.

d. Align index marks on shaft and hub and install the gear (EX-66668) on potentiometer shaft. Press roll pin (6823315-6) into the hub with pliers as shown in Figure 2-11.

e. Install safety wire as shown in Figure 2-12.

NOTE

It may be necessary to rotate potentiometer gear slightly to allow gears to mesh.

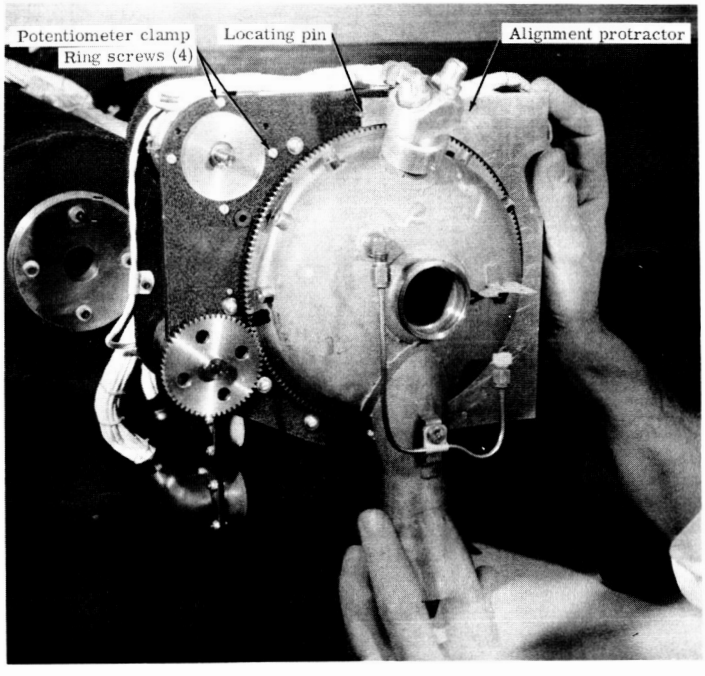


Figure 2-10. Setting control rocket at null position with alignment protractor.

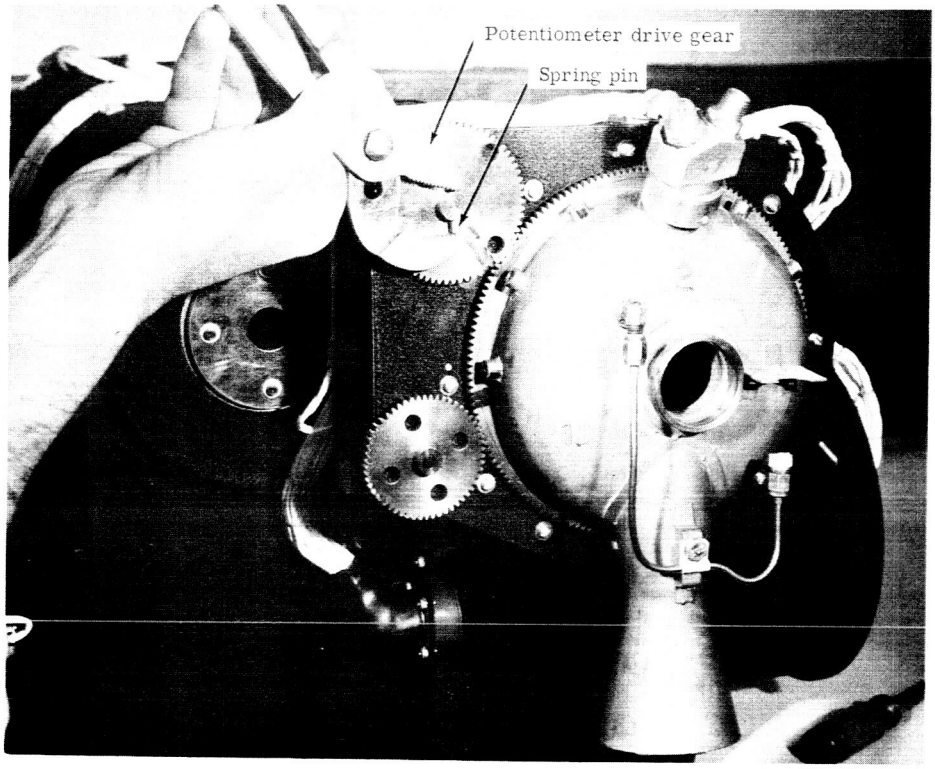


Figure 2-11. Installation of feedback potentiometer gear and pin.

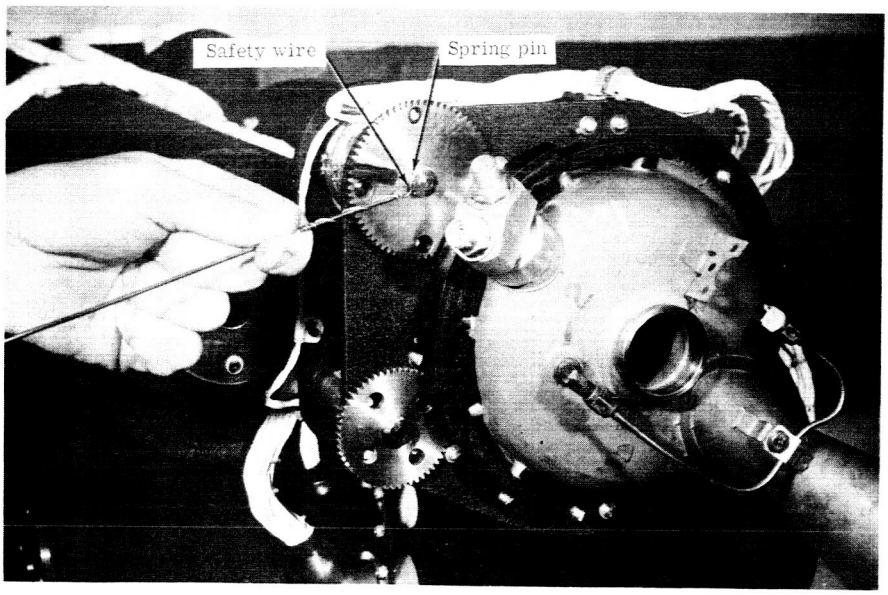


Figure 2-12. Safety wiring spring pins in gears.

2-12. Final alignment procedure for potentiometer feedback gear.

a. Loosen the four screws which secure the feedback potentiometer clamp ring. See Figure 2-10.

b. Recheck null position of rocket motor, rotate the feedback potentiometer until ohmmeter indicates a minimum resistance of 0-7 ohms.

c. Tighten potentiometer clamp screws.

d. Recheck alignment by rotating rocket motor slightly to each side of null and determine if ohmmeter still reads minimum resistance at rocket motor null position.

e. Apply Loctite or Glyptal to the clamp ring screws.

2-13. STOP SCREW ADJUSTMENT

2-14. Two adjustable stop screws are provided on each control rocket to prevent rotation past 65° on either side of null. The stop screws are shown in Figure 1-1.

a. Hold special alignment protractor in place and rotate the control rocket 65° clockwise. Adjust the lower stop screw until it seats against the stop on the control rocket. See Figure 2-13.

b. Rotate the control rocket 65° counterclockwise and repeat adjustment operation (a.) for the upper stop screw.

c. Apply Loctite or Glyptal to the lock screws and tighten against the stop screws.

NOTE

Teflon pads are provided between the lock screws and stop screws to prevent damage to the threads on the stop screws.

d. Install counterbalance weights to nozzle closures.

e. Apply Loctite or Glyptal to screws and secure counterbalance.

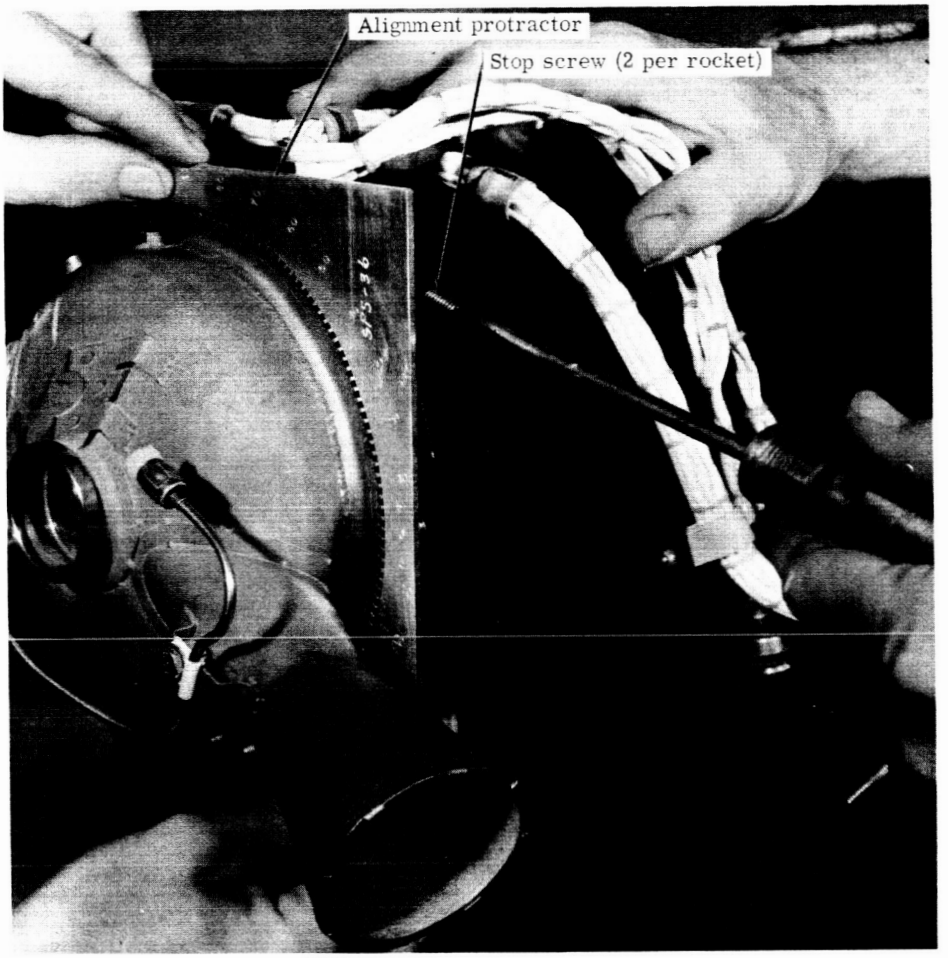


Figure 2-13. Setting stop screws.

2-15. MAIN IGNITER INSTALLATION

2-16. The sequence of assembly of the main igniter assembly (EX-68167) is shown in Figure 2-14. The initiator is removable from the main igniter body as shown in Figure 1-6. This removal allows the igniter to be installed without the initiator, if so desired. This feature also provides for initiator replacement if found to be defective.

WARNING

Do not remove the shorting caps from the initiators until the moment the shorted firing lines are to be connected.

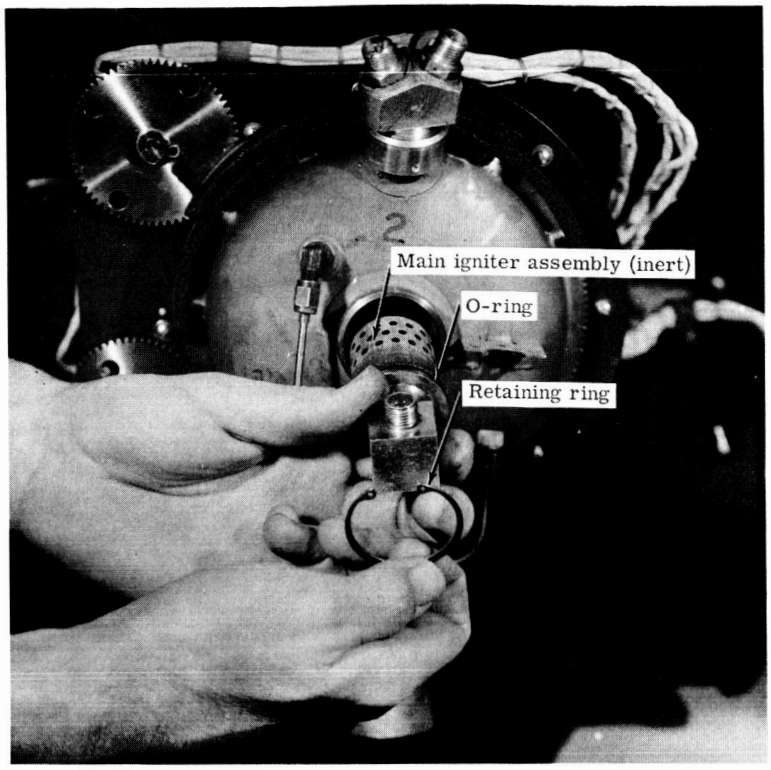


Figure 2-14. Installation of main igniter.

a. Apply an asbestos-loaded cement to the igniter body and around the O-ring. The cement compound and mixture is as follows:

Manufacturer	Compound	Mixture Parts by Weight
Shell Chemical Corp.	EPON 828	100
Thiokol Chemical Corp.	LP3 (Polysulfide)	100
Monsanto Chemical Corp.	Santocel (Filler)	10
Hysol Corporation	TH5 (Hardener)	20
Johns-Manville Corp.	7TFL (Asbestos Floats)	50

NOTE

The cement will set up in 30 to 60 minutes. Therefore, it should not be mixed or applied until the igniter is ready to be installed.

b. Install the igniter in the boss on the rocket motor closure. The electrical connector should be turned toward the thrust reduction assembly.

c. Install the igniter snapring (MS16625-4150). Make certain the snapring has seated properly in the groove.

2-17. THRUST REDUCTION PRESSURE CARTRIDGE INITIATOR INSTALLATION

2-18. The pressure cartridge initiators for the thrust reduction port are shown in Figure 1-7.

WARNING

Do not remove the shorting caps from the initiators until the moment the shorted firing lines are to be connected.

2-19. Install the rubber seal (EX-68152) on the initiators (EX-66682). The seal should be coated with a silicone or petrolatum base lubricant prior to installation.

2-20. Screw the initiator into the thrust reduction cap.

CAUTION

The upper section of the thrust reduction cap should be held with a wrench while tightening the initiators. Torsional strain may occur to the shear section if this is not done.